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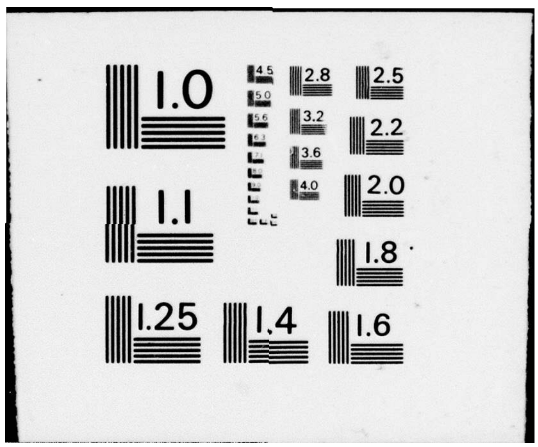
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NWSY TR 76-3

DESIGN AND DEVELOPMENT OF THE SIGNAL, UNDERWATER SOUND, MK 123 MOD 0

DECEMBER 1976

NWS

NAVAL WEAPONS STATION, YORKTOWN, VIRGINIA 23691

by
E. Yancey McGann and Robert M. Johnson

Naval Explosives Development Engineering Department

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This report describes an underwater ordnance item, the Signal, Underwater Sound (SUS), Mk 123 Mod 0, recently released for Fleet use that incorporates a new type of explosive train which has a fuze containing no moving parts. The simplicity, safety, reliability and ruggedness of this fuze make it worthy of consideration for use in other ordnance items.

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FOREWORD

1. This is a report documenting the design and development of the Signal, Underwater Sound, Mk 123 Mod 0 which utilizes a hydroadiabatic fuze. This fuze has no moving parts and requires no out-of-line safety features.

2. The effort reported herein was authorized and funded under the Naval Underwater Systems Center, Newport Project Order 4-0005.

Released by

W. McBride

W. McBRIDE, Director
Naval Explosives Development
Engineering Department
December 1976

Under authority of
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CONTENTS

		Page
FOREWORD		i
I.	GENERAL	1
II.	DESCRIPTION	2
III.	OPERATION	3
IV.	TESTS	4
V.	SUMMARY	6
VI.	REFERENCES	7

FIGURES:

1	General Arrangement - Signal, Underwater Sound (SUS), Mk 123 Mod 0	8
2	Hydroadiabatic Fuze	9
3	Sectionalized Mk 123 Mod 0 SUS	10
4	Signal, Underwater Sound, Mk 123 Mod 0	11

DESIGN AND DEVELOPMENT OF THE SIGNAL, UNDERWATER SOUND, MK 123 MOD 0

I. GENERAL

Underwater Sound Signals, or SUS, have been used for many years as inexpensive, high energy acoustic sources. All SUS contain an explosive charge that is detonated by a hydrostatically operated mechanism. The acoustic energy produced by the detonation of an explosive charge is used for many underwater applications, including bottom mapping, long range signal transmission, position fixing, and anti-submarine warfare. SUS are inexpensive, safe, easy to use and versatile. They can be launched from aircraft and surface ships, and the one described in this report can be launched from submerged submarines.

The Mk 123 Mod 0 SUS was developed to replace the obsolete Mk 9 series SUS and represents a significant advance in signal safety and reliability. It is used for range tracking of submarines during training exercises. The signal is designed to be launched nose end first from signal ejection tubes in submarines by standard hand ramming procedures at depths of less than 300 feet. It sinks at a terminal velocity of 13 feet per second and detonates a 4-ounce explosive charge at a depth of 1000 plus or minus 100 feet.

The Mk 123 Mod 0 SUS design features a hydroadiabatic fuze and a bore and launch depth safety mechanism. The fuze employs the principles of the hydroadiabatic detonator[1] to initiate the explosive charge. This revolutionary new device meets the requirements for fuzes (or arming and firing mechanisms), but contains no moving parts. An out-of-line arming mechanism, which is standard with all other military ordnance, is not required since no primary explosive is used. Firing is accomplished when hydrostatic pressure shears a metal sealing disc and the rapid inrush of water adiabatically compresses a column of air which results in a rapid rise in temperature of the air that in turn ignites a column of explosive.

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[1]McGann, E. Yancey, NWSY TR 70-4, *Development and Testing of the Hydroadiabatic Detonator*, 31 Jul 1970

Since the Mk 123 Mod 0 SUS is launched from the signal ejector tube on a submarine, provision must be made to ensure that the signal cannot be detonated in the tube. As a result, this signal is equipped with a bore and launch depth safety mechanism that would not be used on surface or air launched SUS. This mechanism incorporates the only moving parts in the Mk 123 Mod 0 SUS and prevents initiation of the explosive when the signal is in the signal tube bore, regardless of submarine depth, or when the signal is inadvertently launched at a depth greater than 325 plus or minus 25 feet. The technical manual, NAVSEA OD 49903, *Description, Operation and Launching, Underwater Sound Signal, Mark 123 Mod 0,* specifies a launch depth of 200 feet or less.

Composition CH-6, a standard booster material, and Composition A-3, a standard main charge material, are the only explosive mixtures used in the signal. Both mixtures consist of RDX and a desensitizing coating, thus RDX is the only explosive contained in this signal. Since RDX is virtually inactive chemically, the Mk 123 Mod 0 SUS will have an indefinite shelf life, limited only by the life of the O-ring seals.

II. DESCRIPTION

Figure 1 is a general arrangement of the Mk 123 Mod 0 SUS; Figure 2 shows the details of the hydroadiabatic fuze; Figure 3 is a photograph of a sectionalized model of the signal; and Figure 4 is a photograph of the complete unit. The overall dimensions of the signal are 3 inches in diameter (plus the 1/8-inch thick by 5/8-inch wide valve release lever) by 15 inches long. The total weight of the signal is 6.6 pounds.

The hydroadiabatic fuze, Figure 2, is an assembly of a body, shear disc assembly, washer, cap, disc and adapter. The body, washer and disc are stainless steel. The cap and adapter are steel, cadmium plated. The body has a conical cavity leading into a straight bore which contains a column of Composition CH-6 pressed in place at 10,000 pounds per square inch. The shear disc assembly, which is commonly used in deep sound signals, includes a thin gold shear disc; a stainless steel shear washer, with a calibrated, sharp edged hole; a phenolic washer; and a soft copper ferrule. The ferrule is spun over to contain the other parts of the assembly. The cap screws onto the body and is torqued to compress the washer and shear disc assembly, forming metal-to-metal seals between the shear disc, shear washer, ferrule and body. The adapter, which contains a booster cavity and an air gap hole, is screwed to the body and torqued to secure the .003 inch thick disc in place.

The Mk 123 Mod 0 SUS, Figure 1, is an assembly consisting of a nose, hydroadiabatic fuze, booster, main charge, felt pad, cover, tail tube, tail cap, and bore and launch depth safety mechanism. The nose, cover, tail tube and tail cap are aluminum. The guide pins are steel, cadmium plated. The booster is Composition CH-6 and the main charge is Composition A-3. The guide pins are pressed in the side of the nose. The hydroadiabatic fuze is screwed into the nose and staked in place. Coating compound is applied to fill the gap between the fuze and the bore in the nose to prevent any loose explosive material from coming between two metal surfaces. The booster and main charge are firmly held in place when the tail tube is screwed into the nose against the cover and the felt pad. The tail cap is oriented to align the safety pin hole with the guide pins and secured to the tail tube by the two set screws. Locking compound is used on the threads of the tail tube and the set screws. O-rings, one on the fuze and one under the cover, seal the explosive compartments from water entry.

The bore and launch depth safety mechanism consists of a valve, O-ring, valve spring, valve release assembly, release spring, ball, valve release lever and safety pin. The ball is chrome alloy steel and the other metal parts are steel, cadmium plated. In the assembled signal, the valve release lever is retained against the side of the nose by the safety pin at one end and by the valve release assembly at the other end. The two guide pins in the nose engage holes in the valve release lever to prevent longitudinal or tangential movement. The valve release lever retains the ball from radial movement; the ball retains the valve release assembly by engaging a detent groove; the valve release assembly compresses the release spring and retains the valve; and the valve compresses the valve spring. The portion of the valve with the O-ring fits the radiused hole in the cap of the hydroadiabatic fuze, thus sealing the entry to the shear disc assembly.

III. OPERATION

The Mk 123 Mod 0 SUS is normally launched while the submarine is submerged between periscope depth and 200 feet. The signal is installed in the signal ejection tube, nose end first and oriented so the valve release lever is engaged in the bore rider groove in the tube. The SUS is pushed by hand until stopped by the safety pin. The safety pin is then removed and the signal is pushed approximately 2 inches beyond the breech opening and maintained in this position while the hand rammer (ejector) is secured. After the outboard signal tube door is opened, water enters, surrounds the signal and fills the free flooding tail tube. The hand rammer is then cranked rapidly to the end of its travel, assuring that the signal clears the tube.

Immediately after clearing the signal ejection tube and tube extension, the valve release lever is no longer restrained. The release spring pushes the valve release assembly to cam the ball outward, pivoting the valve release lever off of the guide pins. The release spring continues to push the valve release assembly until it is disengaged from the nose. Both the valve release assembly and lever fall free of the signal. If the launch depth is more than 300 plus or minus 25 feet, the valve is retained to seal the shear disc assembly by hydrostatic pressure, and the signal will sink to the sea bottom without detonating. If the launch depth is less, the valve release spring will force the valve out of the hole in the cap of the fuze, exposing the shear disc assembly to the ambient pressure. The valve and spring fall free and the signal sinks with a stable trajectory, accelerating to a terminal velocity of 13 feet per second.

When the Mk 123 Mod 0 SUS reaches a depth of 1000 plus or minus 100 feet, hydrostatic pressure punches a hole through the shear disc assembly in the hydroadiabatic fuze. The inrushing water acts as a piston to adiabatically compress the air in the conical cavity which terminates in the highly confined CH-6 column. The rapid temperature rise of the air initiates a burning reaction in the explosive column. If this column was very long, the reaction would transform to a detonation. Based on previous work[2], the inclusion of a metal disc plus an air gap is used to minimize the length of the explosive train. When the burning reaction reaches the disc, it ruptures and fragments. The pressure ratio across the bursting disc constitutes a shock wave. The shock wave and hot disc fragments speed across the air gap and initiate high order detonation of the booster. The booster then initiates high order detonation of the 4-ounce Composition A-3 main charge to provide a broadband sound pressure level of 168 decibels relative to 1 dyne/cm^2 at 1 yard.

IV. TESTS

In addition to numerous functional tests in pressure pots and at sea, the hydroadiabatic fuze and the complete SUS passed the following safety tests:

Fuze configuration -

- Jolt.
- Jumble.

[2]Cooper, P. W., Armour Research Foundation of Illinois Institute of Technology, *Final Report ARF Project D178, Ord Project No. TN2-8109 Contract No. DA-11-022-501-ORD-2892*

- 40-foot drop.
- Transportation vibration.
- 5-foot drop.
- Shock.

Complete Mk 123 Mod 0 SUS -

- Temperature and humidity (28-day).
- Transportation vibration.
- Shipboard vibration.
- Recurring impact.
- Temperature and humidity (4-day).
- 5-foot drop.
- 40-foot drop.
- Slow cook-off.
- Fast cook-off.
- Propagation.
- Launch depth safety.

The data package[3] containing the details of the above tests was submitted to the Weapon System Explosives Safety Review Board (WSESRB). The WSESRB recommended approval of the initial production run of one thousand signals for service use. It was recommended that, for follow on production, consideration be given to developing a means to prevent installing the signal into the ejection tube if the bore and launch depth safety mechanism had been removed. The drawings will be changed to include this feature.

---

[3]NAVWPNSTA Yorktown ltr 504:EYM:dgh of 12 May 1976 to NAVSEA (SEA-04H3), Subj: Release of the Signal, Underwater Sound, Mk 123 Mod 0, to service use

At the suggestion of the representative from the Naval Explosive Ordnance Disposal Facility, Indian Head, the WSESRB recommended that an information test be conducted to determine the sympathetic reaction of the fuze in air. The results would assist in the preparation of a render safe procedure. This test was conducted and a report[4] was submitted to the WSESRB. It was concluded that an overpressure as a result of an air blast explosion will not cause an exposed hydro-adiabatic fuze to detonate the signal.

Function tests determined that the hydroadiabatic fuze operates reliably even after being subjected to conditions after which it is not required to function (i.e., jolt, jumble, 40-foot drop and shock). This indicates the ruggedness of the fuze.

V. SUMMARY

The Mk 123 Mod 0 SUS is unique in military ordnance and represents a significant breakthrough in conventional firing train design. The design of the explosive train is a model of simplicity which, by eliminating complex mechanisms with interlocking parts, should prove almost foolproof. Safety is greatly enhanced by eliminating primary explosives and by not having mechanisms in the explosive train subject to various shock and vibration forces during its logistic life. The features and advantages of this signal can be summarized as follows:

- The explosive train has no moving parts.
- The hydroadiabatic fuze is very rugged and functions even after being subjected to such tests as 40-foot drop.
- No primary explosive is used.
- Standard service approved explosives are used, the most sensitive of which is CH-6, a recognized booster material.
- The single explosive material in the signal, RDX, is chemically inactive with good temperature resistance.
- No out-of-line safety mechanism is required and hence, no safety pin or wire is required in the firing train.

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[4]NAVWPNSTA Yorktown ltr 504:EYM:dgh of 10 Sep 1976 to NAVSEA (SEA-04H), Subj: Signal, Underwater Sound, Mk 123 Mod 0; effect of air blast on

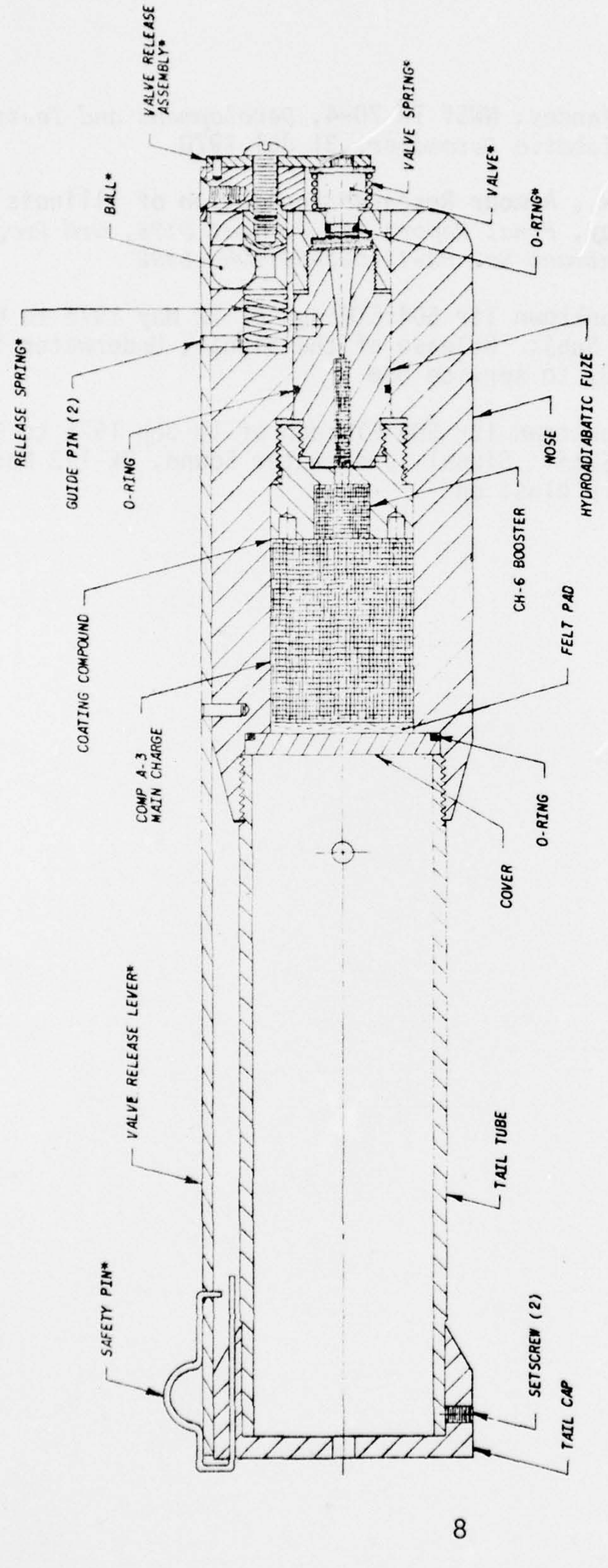
VI. REFERENCES

1 McGann, E. Yancey, NWSY TR 70-4, *Development and Testing of the Hydroadiabatic Detonator*, 31 Jul 1970

2 Cooper, P. W., Armour Research Foundation of Illinois Institute of Technology, *Final Report ARF Project D178, Ord Project No. TN2-8109 Contract No. DA-11-022-501-ORD-2892*

3 NAVWPNSTA Yorktown ltr 504:EYM:dgh of 12 May 1976 to NAVSEA (SEA-04H3), Subj: Release of the Signal, Underwater Sound, Mk 123 Mod 0, to service use

4 NAVWPNSTA Yorktown ltr 504:EYM:dgh of 10 Sep 1976 to NAVSEA (SEA-04H), Subj: Signal, Underwater Sound, Mk 123 Mod 0; effect of air blast on



*PARTS OF BORE & LAUNCH DEPTH SAFETY MECH

FIGURE 1. GENERAL ARRANGEMENT
SIGNAL, UNDERWATER SOUND (SUS), MK 123 MOD 0

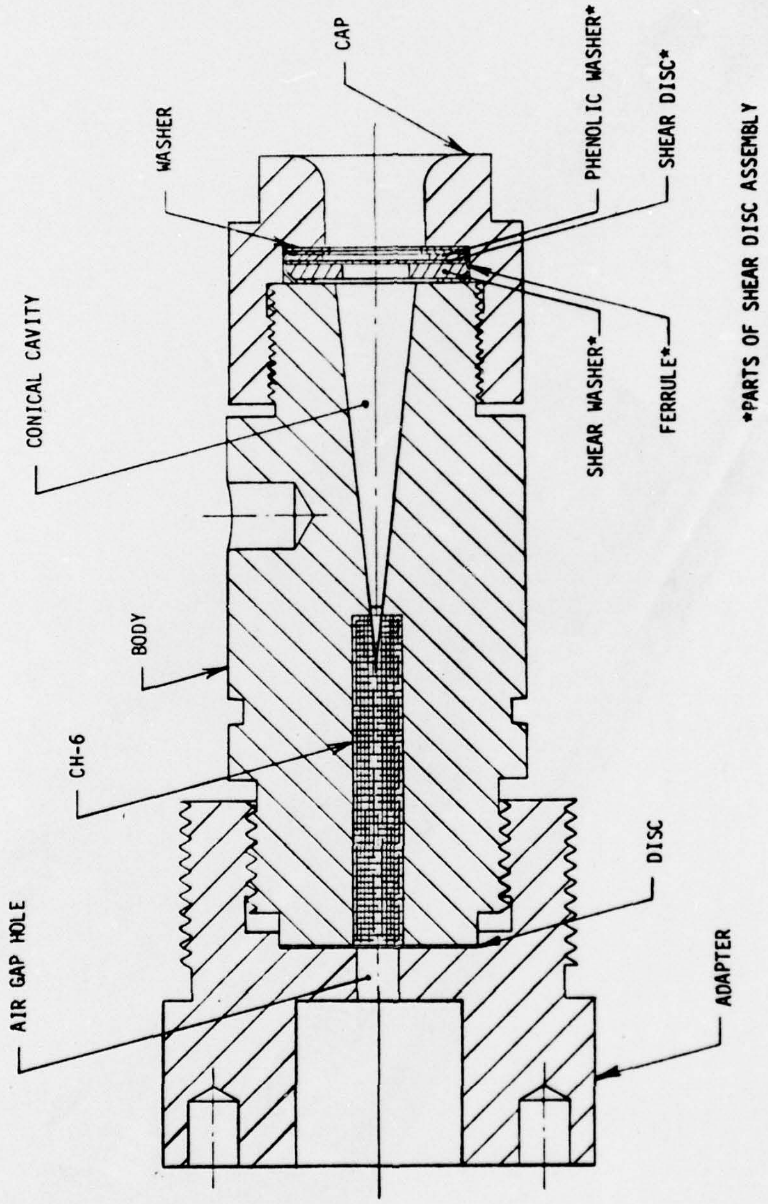


FIGURE 2. HYDROADIABATIC FUZE

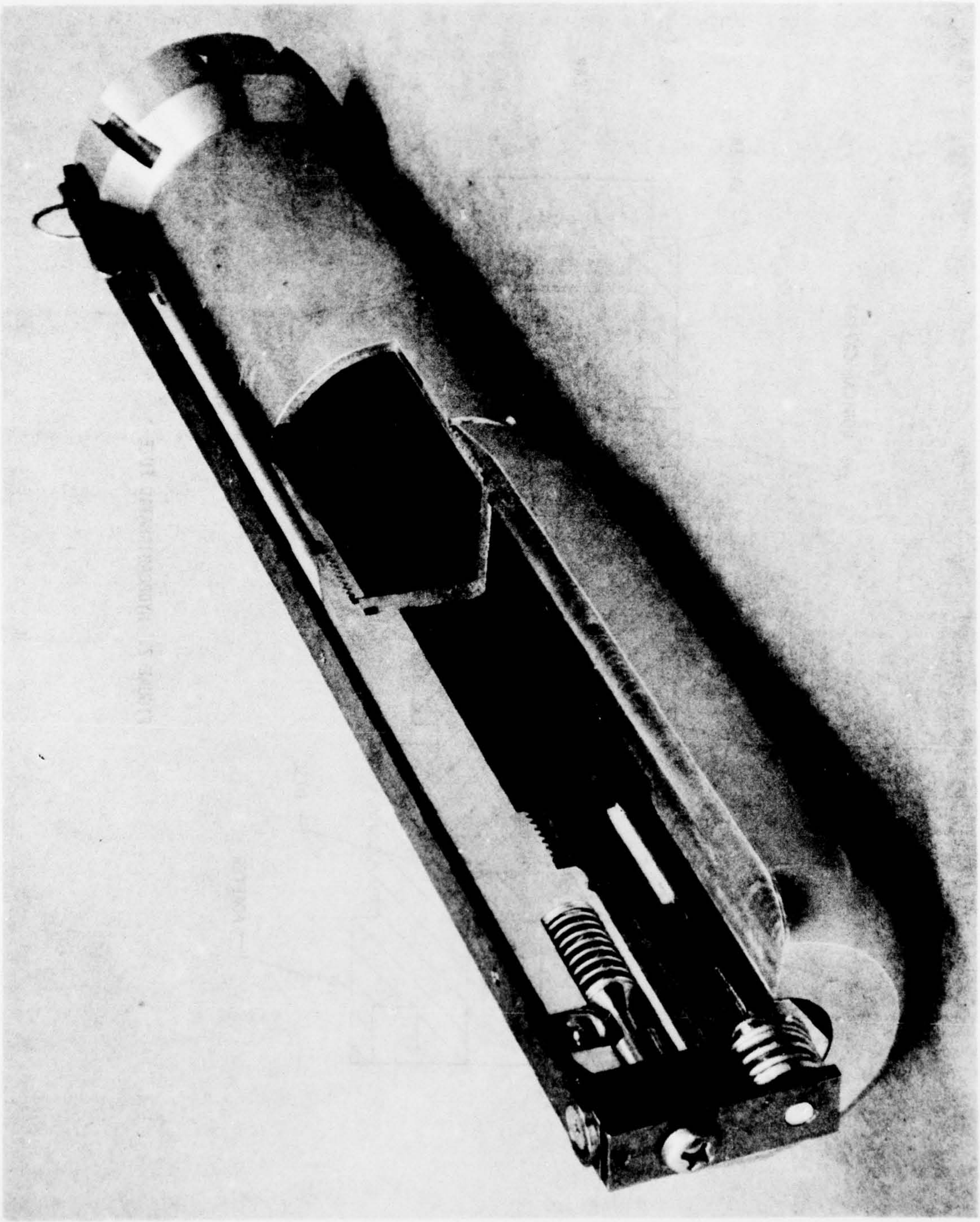


FIGURE 3. SECTIONALIZED MK 123 MOD 0 SUS

FIGURE 4. SIGNAL, UNDERWATER SOUND, MK 123 MOD 0

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